

Report for 2003CA38B: Pyrethroid Insecticides in Nursery Runoff: Transport and Impact on Aquatic Invertebrates

There are no reported publications resulting from this project.

Report Follows

Pyrethroid insecticides in nursery runoff: transport and impact on aquatic invertebrates
– Research Category II, Aquatic Ecosystems

INTRODUCTION: Synthetic pyrethroids are insecticides widely used in both agricultural and urban settings. With the use of organophosphate and carbamate insecticides being restricted, the use of synthetic pyrethroids is expected to further increase. Synthetic pyrethroids have high toxicity to fish and aquatic invertebrates. Recent studies show that surface runoff can transport synthetic pyrethroids into surface streams and can cause potential toxic effects to aquatic organisms. The ecotoxicological effect of pyrethroids in a surface stream will closely depend on its bioavailability, as pyrethroids are known to adsorb strongly to sediment particles and dissolved organic matter. The interaction of phase distribution and aquatic toxicity of pyrethroids is poorly understood at present. This lack of understanding will prevent accurate risk assessment and adoption of scientifically sound regulatory criteria.

Nursery production is a multi-million dollar industry in California. To maintain plant vigor, pesticides and fertilizers are used heavily at nursery sites, and such uses are often coupled with intensive overhead sprinkler and drip irrigation. These processes lead to phenomenal runoffs and discharge of pesticides, nutrients, and sediments in the runoff. Because many nurseries are situated in urban environments, nursery runoffs can impose direct threats to water quality of urban watersheds (e.g., creeks) and the well being of exposed residents. Residues of synthetic pyrethroids were found in runoff from a number of nurseries in the southern California region. This finding poses as an urgent issue for the Regional Water Quality Control Boards, the nursery industries, the local governments, as well as the chemical manufacturers. Consequently, there is an urgent for management practices that may reduce pesticide runoff from nurseries.

RESEARCH PROGRAM:

The overall objective of this project is to evaluate the potential impact of pyrethroid insecticides in nursery runoff on affected water bodies of urban watersheds. Specific objectives are:

- 1). Characterize nursery runoffs by examining levels and makeup of suspended solids and DOM and the association of bifenthrin with these components, and correlate runoff profiles with time, seasons, and on-site activities.
- 2). Investigate influence of suspended solids and DOM on the bioavailability and aquatic toxicity of bifenthrin in runoff.
- 3) Understand the persistence and partitioning of bifenthrin in nursery-derived sediment, and predict the scale and duration of the impact of runoff-borne pyrethroids on receiving water bodies of urban watersheds.

In current monitoring studies, the whole effluent is extracted, from which the total chemical concentration is determined. As the total chemical concentration includes also the fraction that is adsorbed to suspended solids and dissolved organic matter, the measured concentration does not indicate the bioavailable concentration and will likely lead to overestimation in ecotoxicity. We developed a solid phase microextraction (SPME) method that offers selective detection of the dissolved concentration. We further used this method to evaluate phase distribution behavior of bifenthrin and permethrin in stream and runoff waters. In stream water, the majority of synthetic pyrethroids was associated with the suspended solids, and to a lesser extent, with dissolved organic matter (DOM). The freely dissolved phase contributed only 0.4-1.0%. In runoff effluents, the freely dissolved concentration was 10-27% of the overall concentration. The predominant partitioning into the adsorbed phases implies that the toxicity of SPs in surface water is reduced due to decreased bioavailability. This also suggests that monitoring protocols that do not selectively define the freely dissolved phase can lead to significant overestimation of toxicity or water quality impacts by SPs.

In close collaboration with nursery growers, we have carried out studies to understand the fate and distribution of bifenthrin and permethrin in nursery runoff, and to develop best management practices (BMPs)

to reduce their load in the runoff. The experimental site was a 100-acre commercial nursery located in southern California. The BMPs included optimized irrigation schemes, use of sediment traps/ponds, addition of polyacrylamide (PAM) into the effluent, and establishment of a vegetative strip. Monitoring data showed that the BMPs were highly effective in reducing the runoff of the synthetic pyrethroids. The level of bifenthrin or permethrin in the runoff flow was consistently reduced by $> 92\%$. The mechanism for pesticide reduction was removal of suspended solids caused by the series of BMPs. These BMPs are inexpensive and of low maintenance, and therefore are feasible for implementation by other nursery growers, or at other runoff sites.